

Supplement Analysis

Magnesium Hydroxide Precipitation Process at the Plutonium Finishing Plant, 200 West Area, Hanford Site, Richland, Washington

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INTRODUCTION

The U.S. Department of Energy (DOE) is planning to stabilize plutonium-bearing solutions presently stored at DOE's Plutonium Finishing Plant (PFP) located on the Hanford Site near Richland, Washington. The environmental impacts of the stabilization of approximately 4,800 liters (1,270 gallons) of solutions, containing approximately 335 kilograms (740 pounds) of plutonium, were analyzed in DOE/EIS-0244-F, *Final Environmental Impact Statement, Plutonium Finishing Plant Stabilization* (PFP EIS), issued in May 1996. In the Record of Decision (ROD, 61 FR 36352, July 10, 1996), DOE selected two alternatives: 1) ion exchange, vertical calcination, and thermal stabilization; and 2) hydroxide precipitation followed by thermal stabilization. At the time this strategy was developed, it was anticipated that hydroxide precipitation would be used to stabilize no more than 20 percent of the solution inventory. Currently, DOE is pursuing stabilization of the entire inventory of plutonium-bearing solutions via hydroxide precipitation, beyond the 20 percent addressed in the ROD.

The purpose of this Supplement Analysis (SA), prepared in accordance with Section 1021.314 of the DOE *National Environmental Policy Act of 1969* (NEPA) regulations, is to provide a basis for a determination of whether or not a supplemental environmental impact statement (EIS) is required before stabilization of all PFP plutonium-bearing solutions via a magnesium hydroxide precipitation process (beyond the 20 percent addressed in the ROD) is performed. The analysis in this SA incorporates the most current magnesium hydroxide precipitation process knowledge and data, which reflect differences when compared with PFP EIS analyses.

Section 1502.9(c) of the Council on Environmental Quality Regulation for Implementing the Procedural Provisions of NEPA (40 CFR 1500-1508) requires the preparation of a Supplemental EIS if: (1) the agency makes substantial changes in the proposed action that are relevant to environmental concerns or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. Section 1021.314(c) of the NEPA Regulations (10 CFR 1021, 61 FR 36222, July 9, 1996) provides that where it is unclear whether a supplemental EIS is required, DOE will prepare a Supplement Analysis to support a DOE determination with respect to the criteria of 40 CFR 1502.9(c).

BACKGROUND

The environmental impacts of the stabilization of approximately 4,800 liters (1,270 gallons) of solutions, containing approximately 335 kilograms (740 pounds) of plutonium, were analyzed in DOE/EIS-0244-F, *Final Environmental Impact Statement, Plutonium Finishing Plant Stabilization* (PFP EIS), issued in May 1996. A summary of those impacts is presented in Appendix A. In the ROD, DOE selected two alternatives: 1) ion exchange, vertical calcination, and thermal stabilization; and 2) hydroxide precipitation followed by thermal stabilization. As stated in the ROD:

“For Plutonium-bearing solutions two alternatives are selected.

-Ion exchange, vertical calcination, and thermal stabilization. Most plutonium-bearing solutions will be stabilized by thermal treatment using a vertical calciner. For this application, the feed material will include plutonium nitrate solutions, solutions containing chlorides, caustic solutions, and dissolved plutonium fluoride. In order to utilize the vertical calcination process, some of the plutonium-bearing solutions will require pretreatment by ion exchange to remove chemical constituents that are not compatible with the vertical calcination process or the process equipment. In addition, the calciner product may require further thermal stabilization in order to meet DOE’s “Criteria for Safe Storage of Plutonium Metals and Oxides” (DOE-STD-3013-94).

The combined ion exchange/vertical calciner/thermal treatment process will be capable of processing most of the inventory of plutonium nitrate and chloride solutions. It also will be able to process the plutonium fluoride solids if they are first dissolved and converted to the nitrate form using an acid dissolution pretreatment operation. This will increase the quantity of material to be stabilized from 335 kg (737 lb) plutonium to 338 kg (745 lb) of plutonium associated with approximately 4,800 l (1,268 gal) of solution.

-Hydroxide precipitation followed by thermal stabilization. Plutonium-bearing solutions could be alternatively treated by a relatively simple hydroxide precipitation process. The resultant plutonium precipitate will then be thermally stabilized to an oxide form capable of meeting DOE’s ‘Criteria for Safe Storage of Plutonium Metals and Oxides,’ (DOE-STD-3013-94). This alternative would be applied to the portion of the plutonium-bearing solutions that are determined to be unsuited for vertical calcination. An example would be material that could create a resinous residue or cause corrosion within the vertical calciner. No more than 20 percent of the plutonium solutions are anticipated to fall into this category.

Caustic or other hydroxide-forming reagents will be added to the solution, gradually increasing the pH until insoluble plutonium hydroxide is formed. The plutonium hydroxide and other metal impurities, such as nickel, chromium, and iron, will precipitate out and be filtered from solution. The filtered solids will then be thermally processed into a stable oxide form.”

Potential environmental impacts associated with both processing alternatives were presented in the PFP EIS, based on 100 percent of the solutions being stabilized via either method. A brief synopsis of the aforementioned impacts is provided in Appendix A.

In summary, the strategy articulated in the ROD was to process the bulk of the solutions via vertical calcination. It was recognized that solutions containing impurities would require pretreatment before calcination to avoid damaging the calciner. Moreover, there were some impurities that were not removed by the pretreatment of choice, ion exchange. For this reason a second solution stabilization method, hydroxide precipitation, was identified in the ROD. At the time this strategy was developed, it was anticipated that hydroxide precipitation would be used to stabilize no more than 20 percent of

the solution inventory. Currently, DOE is pursuing stabilization of the entire inventory of plutonium-bearing solutions via hydroxide precipitation (beyond the 20 percent addressed in the ROD). The analysis in this SA incorporates the most current magnesium hydroxide precipitation process knowledge and data, which reflect differences when compared with PFP EIS analyses.

In 1996 two DOE Sites, Hanford and Rocky Flats Environmental Technology Site (RFETS), each had an inventory of plutonium nitrate solutions requiring stabilization. Hanford had pursued the strategy of vertical calcination while Rocky Flats selected hydroxide precipitation. By the spring of 1999, Rocky Flats had stabilized 15,000 liters of plutonium nitrate solutions via hydroxide precipitation. In contrast, events at Hanford resulting in shutdown of PFP for two years had severely impacted progress. Solution stabilization was limited to a few liters during testing. In addition, Hanford had committed to completion of solution stabilization before the end of the calendar year 2002.

The strategy defined in the ROD centered on maximizing utilization of the calciner. This led to two methods for stabilizing impure solutions: 1) ion exchange pretreatment for removal of troublesome anions such as fluoride (before stabilization in the calciner), 2) hydroxide precipitation followed by thermal stabilization. However, RFETS had demonstrated that impure solutions containing anions could be stabilized via hydroxide precipitation. In addition, the ion exchange pretreatment system at PFP had not been designed. For schedule and cost considerations, in the spring of 1999 it was recommended that ion exchange pretreatment be eliminated and all impure solutions be processed by hydroxide precipitation/thermal stabilization.

Since pure plutonium nitrate solutions can be stabilized by either the vertical calciner or hydroxide precipitation, the method selection logic was revisited during the first half of 1999. A prototype calciner had been built and installed, and had been successfully tested with plutonium nitrate solutions for periods up to 1.5 hours. The required continuous operation had not been proven. Construction of a production calciner was approximately 70 percent complete.

An independent engineering firm performed an evaluation to determine if any technical issues existed that might preclude the ability of PFP to meet its commitments. A study was conducted over a two-week period by a multi-disciplinary team consisting of experts in the fields of mechanical engineering, electrical engineering, nuclear safety, occupational and radiological safety, operations, metallurgy, and environmental protection. The following synopsis is from *Vertical Denitration Calciner Technical Evaluation for Plutonium Finishing Plant*:¹

1. Cost: Continuing the project using both a production-scale vertical calciner to process pure solutions and hydroxide precipitation to process impure solutions was projected to be \$3.7 million dollars more expensive than using the hydroxide process alone.
2. Schedule: One of the advantages that led to selection of the vertical calciner was the 'one step' process (thermal treatment in muffle furnace was not needed). However, this assumption may not be valid, as DOE Standard DOE-STD-3013, *Criteria for Safe Storage of Plutonium Metals and Oxides* requires 2 hours at 950 centigrade, which can only be proven in a batch

¹*Vertical Denitration Calciner Technical Evaluation for Plutonium Finishing Plant*", transmitted via letter, NAN-99-175, Neil A. Norman to John Sinclair, dated April 23, 1999.

process. The vertical calciner utilizes a continuous flow process. Although the average residence time in the calciner can be proven, the absolute residence time of each particle cannot. This may result in the need for thermal stabilization post-treatment or running the calciner in a batch mode.

3. Equipment/Component Reliability: The performance of vertical calciner component reliability has not been validated. Therefore, there is a significant risk that unanticipated operational failures might occur and result in cost or schedule impacts.
4. Maintainability: Vertical calciner component maintenance will be difficult due to the limited installation space. Many of the components are very difficult to reach/access.
5. ALARA Considerations: An ALARA review has not been performed for a production calciner. However, the exposure rates from the prototype feed tank approach 100 mrem/hour and design changes may be required. Exposure rates during operation of the production calciner could result in a periodic high radiation area with attendant access control problems as well as excessive personnel exposures.
6. Documentation: The documentation requires considerable effort in the areas of: as-built design; functional and design criteria need to be consolidated into a clear technically defensible baseline; operation and maintenance procedures; ALARA review; technical evaluation of a production calciner.

Evaluations have concluded that the calcination system, while potentially viable, would require substantial effort to make operational on a processing scale. Further, because of the high temperature operating conditions and an installation configuration that makes for difficult maintenance and repair, time requirements to meet stabilization goals would be exceeded. As a result of these considerations, DOE is pursuing stabilization of the inventory of plutonium-bearing solutions via hydroxide precipitation processing, and has suspended activities associated with calciner development indefinitely.

The following discussion is limited to addressing impacts associated with the magnesium hydroxide precipitation process. Section 3.3.1.1 of the PFP EIS, *Hydroxide Precipitation Followed by Thermal Stabilization of the Plutonium-Bearing Solutions*, addressed the following:

“Approximately 4,800 l (1,268 gal) containing 338 kg (745 lb) (including the 3 kg [6.6 lbs] plutonium fluorides) of plutonium would be stabilized by this alternative. The resultant product, including americium and other impurities, would be packaged in accordance with the DOE storage standard and placed in the vault at the PFP Facility for storage.”

As described in the PFP EIS, Section 3.3.1.1, solutions would be retrieved and transferred to an appropriate glovebox. Differing feed compositions could be blended before precipitation. The plutonium-bearing solutions would be transferred to another glovebox where the precipitation would be performed. The process of precipitating metal hydroxides from acidic solutions would involve the use of solid magnesium oxide reagent to raise the pH and precipitate the metals. Magnesium hydroxide would be formed on contact with the aqueous solution, and no additional liquid additives

would be necessary. Filtration of the solids would be accomplished by centrifuging or allowing the precipitate to settle and decanting the liquid. The remaining solids would be captured on filter paper, washed with water, and dried before undergoing thermal treatment in a muffle furnace.

Thermal processing in an air atmosphere would be used to convert the precipitated plutonium hydroxide to stabilized plutonium oxides. This could be performed in batches in muffle furnaces located nearby. After cooling, a sample of the oxide product would be sent to the analytical laboratory to verify that the material meets storage specifications for water content. Product failing to meet the storage specifications would be recycled through the thermal stabilization process. Nondestructive analyses would be performed on the packaged product to determine isotopic composition before transfer to the vault(s) at PFP.

Offgases and liquid effluents would be generated as a result of routine operations. Filtered offgases would be released through the existing 291-Z-1 stack. Liquid effluents (i.e., filtrate and aqueous wash solutions) either could be transferred to the 200 Areas tank farms or immobilized in cement and managed as transuranic or transuranic mixed waste. Solid transuranic waste would be generated during glovebox operations; this waste would be packaged and transferred to existing Hanford Site solid waste management facilities.

Hydroxide precipitation could be performed in new or existing gloveboxes in PFP. A new batch precipitator would be used to do the precipitation. Filtration would be conducted with standard equipment. Thermal treatment would be performed either in the same glovebox or an adjacent glovebox. Alternatively, the dried filter cake could be transferred to another glovebox in PFP for thermal treatment in muffle furnaces.

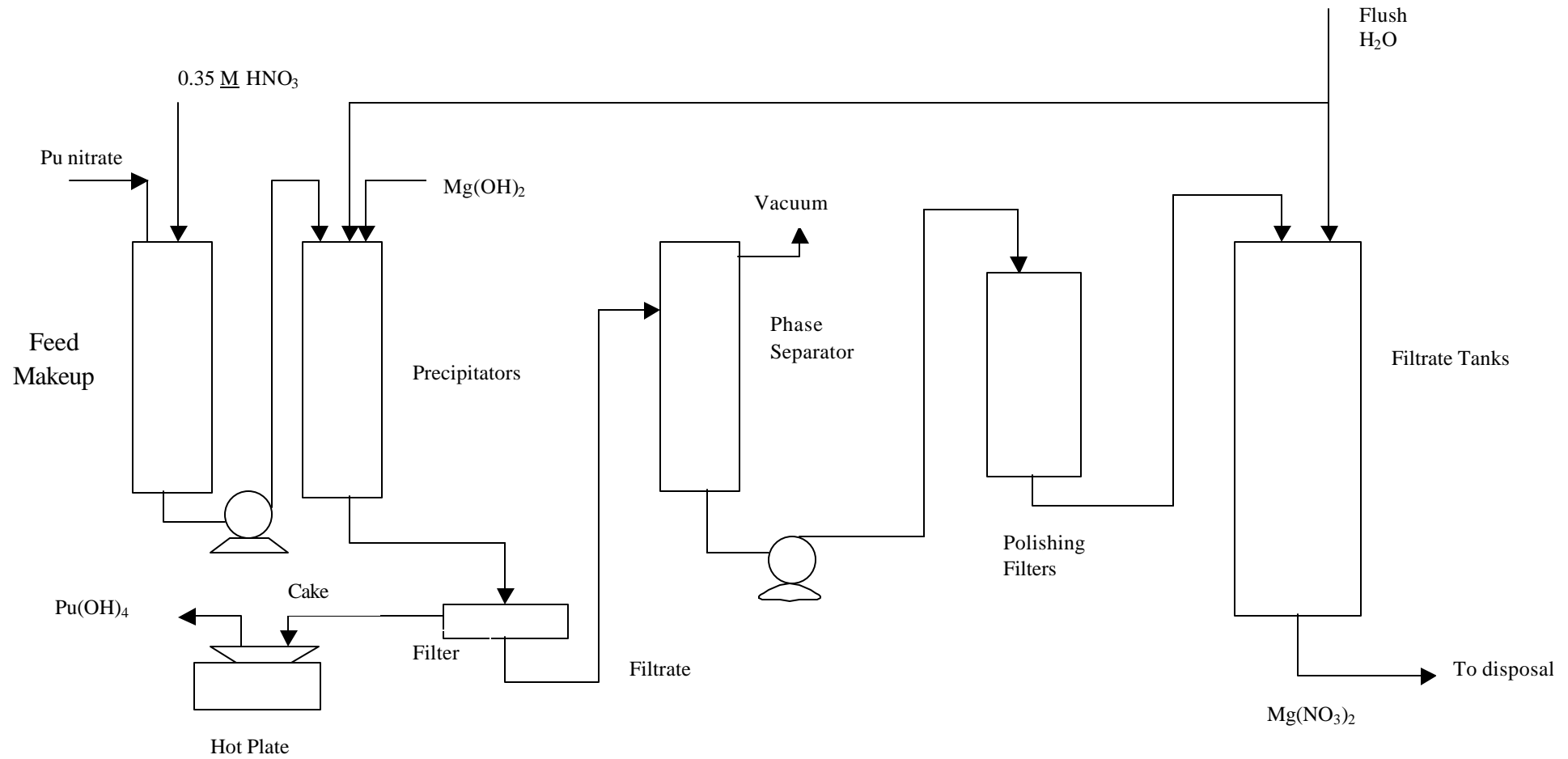
COMPARISON OF CURRENT MAGNESIUM HYDROXIDE PRECIPITATION PROCESS CONCEPT TO THE PFP EIS

Estimates of the potential environmental impacts associated with stabilization of PFP's plutonium-bearing solutions are included in Chapter 5.0 ("Environmental Impacts") of the PFP EIS and are based on the total quantity of material to be stabilized at PFP. That is, the analysis in the PFP EIS considered the entire aforementioned 4,800 liters (1,270 gallons) of plutonium-bearing solutions (containing 338 kilograms [745 pounds] of plutonium). There is no change in the total quantity of plutonium-bearing solutions to be stabilized.²

The general unit operations of hydroxide precipitation are the same as presented in the PFP EIS. Figure 1 shows the current concept of the process. A weak nitric acid stream (0.35 molar) would dilute the solutions as stored to a nominal acid strength of 3.0 molar in existing facilities within PFP. The blended feed would be transferred to the new equipment.

² Following the PFP EIS (May 1996), some solutions have been used in process development. The entire inventory is considered herein for completeness and conservatism.

Figure 1. Simplified Magnesium Hydroxide Precipitation Process



The solutions would be fed to three precipitation vessels where the magnesium hydroxide powder would be added manually. Sparging air (via vacuum) up through the vessels would agitate the mixture, allowing efficient reaction to occur. The precipitators would be drained by gravity to an open pan filter where the plutonium solids would be collected. The filtrate would be transferred via vacuum into a phase separator for collection. The filtrate would be further filtered through polishing filters before being pumped to temporary storage in the filtrate tanks. After laboratory analysis verifying that the plutonium concentration meets the disposal requirements, the filtrate would be disposed of using existing facilities.

The plutonium solids would be transferred from the filter to an open metal container (i.e., boat) and heated on a hot plate to further dry the material within the glovebox. The plutonium would be allowed to cool and conveyed to muffle furnaces. Final stabilization of the precipitate would be performed in the existing muffle furnaces to convert the dried plutonium hydroxide to plutonium oxide. Stabilized plutonium oxide would be packaged appropriately and stored in PFP vault(s) pending final disposition.

Environmental Impacts

Overall, no substantial changes in environmental impacts (as described in the PFP EIS, Chapter 5.0, Section 5.1) are anticipated for: geology, seismology, and soils; water resources and hydrology; noise and sound levels; ecosystems; population and socioeconomic; local economy, employment, and income; population; housing; local infrastructure; environmental justice and equity; transportation; land use; and cultural resources.

- Construction

As stated in the PFP EIS, hydroxide precipitation could be performed in new or existing gloveboxes in PFP. A new glovebox would be installed in the 234-5Z Building to support solutions stabilization. Minor modifications to the existing PFP would be provided supporting glovebox operations (e.g., electrical hookups, ventilation system tie-ins). Similar facility modifications have been, and are being, routinely conducted on the Hanford Site. These are not atypical of commercial industrial activities, and would not be expected to present unique environmental impacts during routine construction activities or postulated accident scenarios. These minor modifications would not be expected to provide substantial impacts beyond those addressed in the PFP EIS.

- Routine Operations

A summary of potential routine operational environmental impacts associated with the current concept, compared to those presented in the PFP EIS, is shown in Table 1.

As discussed in the PFP EIS, offgases and effluents would result from routine operations. Each are discussed below.

Gaseous Effluents

Gaseous effluents from stabilization activities would include air, water vapor, and small quantities of plutonium oxides. Gaseous effluents would be released through the existing 291-Z-1 stack. The hydroxide precipitation method would not have air emissions associated with the process, but the follow-up muffle furnace process would have projected emissions.³ As stated in the PFP EIS, from a standpoint of criteria pollutants, environmental impacts to air quality appear to be insignificant.

The low impacts projected in the PFP EIS due to air emissions have been supported by recent air emissions data reports. Specifically, the estimated abated total effective dose equivalent to the hypothetical offsite maximally exposed individual (as reported in DOE/RL-99-77, Rev. 0, *Radioactive Air Emissions Notice of Construction for the Magnesium Hydroxide Precipitation Process at the Plutonium Finishing Plant*) is 0.1 millirem. This is based on a conservative potential-to-emit abated source term of approximately 0.2 grams (4×10^{-4} pounds) of plutonium.

Table 1. Comparisons of Potential Environmental Impacts
Offgases and Effluents from the Magnesium Hydroxide [Mg(OH)₂] Precipitation Process

Component	PFP EIS*	Current Concept
Air quality: Releases of PM ₁₀ (assumed to be plutonium oxides)	0.042 gram (9.3×10^{-5} pounds)	0.2 grams (4×10^{-4} pounds)
Filtrate – pH adjusted and liquid transferred to tank farms	~5,000 liters ((1,300 gallons)	~91,000 liters (24,000 gallons)
Filtrate – sorbent addition (if necessary); liquid transferred to Effluent Treatment Facility; used sorbent to Central Waste Complex	Not Analyzed	~23,000 liters (6,000 gallons) eight 208-liter (55-gallon) drums
Filtrate – immobilized on site (at PFP)	~7.6 cubic meters (9.9 cubic yards) [40 208-liter (55-gallon) drums]	~22.8 cubic meters (29.7 cubic yards) [one hundred and twenty 208-liter (55-gallon) drums]
Filtrate – immobilized offsite (at ATG)	Not Analyzed	Transfer ~23,000 liters (6,000 gallons) to ATG for solidification Receive <120 drums (208-liter [55-gallon] drums) from ATG
Solid waste	Would not exceed design capacities of existing waste management facilities	No change anticipated

*Extracted from PFP EIS, Chapter 3.0, Section 3.3.1.1 (based on entire solution inventory).

³PFP EIS, Chapter 5.0, Section 5.2.2.1.

Although no data are provided in the PFP EIS for comparison, nonradiological impacts due to air emissions also are projected to be low. Recently, toxic air pollutant emission rates and oxides of nitrogen emission rates have been calculated. These data, shown in Table 2, were provided to the State of Washington Department of Ecology on March 2, 2000 (Letter, 00-OSS-162, J.E. Rasmussen [RL] to M.A. Wilson, *New Source Review for Applicability of Washington Administrative Code [WAC] 173-400 and WAC 174-460: Magnesium Hydroxide Precipitation*).

Table 2. Toxic Air Pollutant and Oxides of Nitrogen Emission Rates from the $\text{Mg}(\text{OH})_2$ Precipitation Process

Pollutant	$\text{Mg}(\text{OH})_2$ Process Emission Rate
Nitric acid [HNO_3]	2.9×10^{-11} (pounds per hour)
Manganese compounds [$\text{Mn}(\text{NO}_3)_2$ + MnO_2]	4.3×10^{-9} (pounds per hour)
Iron salts	5.0×10^{-14} (pounds per hour)
Oxides of nitrogen (NO_x)	92 (pounds per year)

Liquid Effluent

There is a change in the projected volume of liquid effluent resulting from routine solution stabilization operations. Current process knowledge indicates that the magnesium hydroxide process filtrate would need to be diluted to meet 200 Areas tank farm acceptance criteria. Treating the filtrate would result in approximately 91,000 liters (24,000 gallons) of waste to be transferred to Tank Farms.

Alternatively, the process filtrate could be immobilized in cement or in a sorbent, and placed in 208-liter (55-gallon) drums. As many as 120 drums could be generated; the drums would be transferred to existing solid waste management facilities on the Hanford Site. This increase in projected waste effluent would be within the operating parameters of existing waste management facilities.

Also being evaluated for disposition of the liquid effluent is use of the existing 200 Area Effluent Treatment Facility (ETF). Up to approximately 23,000 liters (6,000 gallons) of filtrate could be sent to the ETF via overland transport in appropriate containers. The filtrate would be treated at PFP (if necessary) with a sorbent to reduce the plutonium concentration sufficiently for acceptance. Approximately eight 208-liter (55-gallon) drums of used sorbent would be transported to existing solid waste management facilities on the Hanford Site.

Additionally, since the PFP EIS ROD was issued, a commercial low-level mixed waste treatment facility has been constructed and operated in Richland, Washington. DOE has evaluated the potential environmental impacts of transporting contact-handled low-level mixed waste from the Hanford Site to the Allied Technology Group (ATG) Mixed Waste Facility for non-thermal treatment, with return of the treated waste to the Hanford Site for eventual land disposal. Those impacts are analyzed in DOE/EA-1189, *Non-Thermal Treatment of Hanford Site Low-Level Mixed Waste*, and are incorporated by reference. The scope of this SA includes transferring the process

filtrate into 208-liter (55-gallon) drums and transporting the drums via overland truck to the ATG facility. The treated wastes would be returned to the Hanford Site. A bounding scenario of treatment of 23,000 liters (6,000 gallons) represents approximately one percent of the total Hanford waste volume in the scope of DOE/EA-1189.⁴ A summary of potential environmental impacts as presented in the Finding Of No Significant Impact for DOE/EA-1189 is provided in Appendix B. A recently conducted safety evaluation for the collection and packaging of up to fifty 208-liter (55-gallon) drums of process filtrate,⁵ which concluded that the activity is within the safety envelope provided by existing PFP safety documentation, is summarized in Appendix C.

Radiological Consequences

Routine radiological dose consequences to the PFP Facility worker, the onsite worker, and the maximally exposed offsite individual have been considered and compared to consequences presented in the PFP EIS. The doses and calculated latent cancer fatalities (LCF) are shown in Table 3. As discussed in the PFP EIS, minimal releases to the environment of radiological constituents are anticipated due to the extensive filtration systems used at PFP. From a health effects standpoint, there would be no meaningful effect on Hanford Site workers, the public, or the environment. No change in the total inventory of plutonium-bearing materials to be subjected to thermal stabilization in the 234-5Z Building is anticipated; therefore, the emissions through the 291-Z-1 stack would not be expected to increase as a result of the proposed action.

Further, it would be expected that potential doses to PFP Facility workers would be no greater than those projected in the PFP EIS. In fact, a recent dose study (HNF 5398, *Anticipated Radiological Dose to Worker for Plutonium Stabilization and Handling at PFP – Project W-460*) indicated potentially lower doses to the PFP worker, supporting the bounding analysis presented in the PFP EIS.

As discussed in the PFP EIS, minimal releases to the environment of radiological constituents are anticipated because of the extensive filtration systems used at PFP. From a health effects standpoint, there would be no meaningful effect on Hanford Site workers, the public, or the environment.

⁴ A total waste volume of 2,600 cubic meters (3,400 cubic yards) was evaluated in DOE/EA-1189. This equates to 2,600,000 liters. The aforementioned (23,000 liters) process filtrate waste stream composition is consistent with the physical and chemical characteristics of wastes analyzed in DOE/EA-1189. That is, contact-handled low-level mixed waste, which is made up of both low-level radioactive and hazardous constituents.

⁵ Unreviewed Safety Question evaluation, ID # PFP-2000-31, "Download Mg(OH)₂ Filtrate into 55 Gallon Drums," August 14, 2000.

Table 3. Comparison of Potential Environmental Impacts
Radiological Dose Consequences from the $Mg(OH)_2$ Precipitation Process

	Doses (rem effective dose equivalent)			Latent cancer fatalities		
	Hanford Site worker population dose (5 workers) (person-rem)	Max. site boundary Individual (rem)	PFP Facility Worker (person-rem)	Hanford Site worker population dose (5 workers)	Max. site boundary Individual	PFP worker
PFP EIS ^a	2.0×10^{-4}	7.4×10^{-6}	8.5×10^1	7.9×10^{-8}	3.7×10^{-9}	3.4×10^{-2}
Current Concept ^b	No change anticipated	No change anticipated	3.2×10^1	No change	No change anticipated	1.3×10^{-2}

a PFP EIS, Appendix D

b HNF-5398, Rev. 1, *Anticipated Radiological Dose to Workers for Plutonium Stabilization and Handling at PFP, Project W-460*, November 1999.

Accident Scenarios

Accident scenarios were analyzed in the PFP EIS (Appendix C) for stabilization activities. The bounding accident scenario was postulated to be an explosion and/or fire during muffle furnace operations. A subsequent supplement analysis to the PFP EIS, *Increasing Batch Size for Thermal Stabilization of Plutonium Finishing Plant Metals, Oxides, and Process Residues, 200 West Area, Hanford Site, Richland, Washington* (DOE/EIS-0244/SA2), provided an evaluation of potential environmental impacts associated with an increase in furnace loading to 2.5 kilograms of plutonium. Table 4 shows dose consequences to PFP Facility workers, calculated to be 1,000 person-rem, as well as the maximum onsite Hanford worker and the maximum site boundary individual.

Table 4. Impacts from Accidents for Batch Thermal Stabilization of PFP Oxides and Process Residues (up to 2.5 kilograms of material at risk)*

Doses (effective dose equivalent)			Latent Cancer Fatalities		
Maximum Onsite Hanford Worker (rem)	Maximum Site Boundary Individual (rem)	PFP Workers (person-rem)	Maximum Onsite Hanford Worker	Maximum Site Boundary Individual	PFP Workers
1×10^{-3}	3×10^{-4}	1×10^3	4×10^{-7}	2×10^{-7}	4×10^{-1}

* From DOE/EIS-1044-FS/SA2, *Increasing Batch Size for Thermal Stabilization of Plutonium Finishing Plant Metals, Oxides, and Process Residues, 200 West Area, Hanford Site, Richland, Washington*.

An accident scenario directly associated with the hydroxide precipitation process was identified in the PFP EIS. Specifically, in the PFP EIS (Section 5.2.1.2):

“To quantify the impacts from accidents associated with hydroxide precipitation, the fire/explosion accident is evaluated as bounding. The total amount of material at risk in the process glovebox is 704 g (1.5 lb) plutonium. The airborne release fraction is taken to be

1.2×10^{-6} , with all of the airborne material assumed to be of respirable size. Doses to the hypothetical maximally exposed PFP Facility worker from this step under the same conditions as described for the muffle furnace accident would be 0.072 rem, with an associated LCF of 2.9×10^{-5} .”

Recently, potential accident scenarios pertaining specifically to the current magnesium hydroxide precipitation process have been analyzed (Letter, dated June 28, 2000; R. D. Hanson to K.A. Klein, *Contract Number DE-AC06-96RL13200; Engineering Change Notice 658096, “Incorporation of the Magnesium Hydroxide Precipitation Process Addendum to the Plutonium Finishing Project Final Safety Analysis Report,”* and *Engineering Change Notice 659386, “Modification of WHC-SD-CP-OSR-010 Plutonium Finishing Plant Operational Safety Requirements Revision 0-M to Support Plutonium Stabilization and Disposition Activities”*). A hazards analysis identified three hazards which warranted analysis as representative accidents associated with the magnesium hydroxide precipitation process: plutonium feed solution supply line rupture; glovebox fire; and glovebox seismic event. A summary of each accident scenario is provided below.

- Plutonium feed solution transfer line rupture

This accident scenario was evaluated for normal operations and during a seismic event. In both instances, the existing safety envelope of the PFP FSAR (*Plutonium Finishing Plant Final Safety Analysis Report*, HNF-SD-CP-SAR-021, Rev. 1) addressed potential consequences. No additional safety analyses were necessary.

- Glovebox fire

In this scenario, plutonium-bearing nitric acid solutions before magnesium hydroxide has been added, or plutonium hydroxide precipitate and neutralization products after addition of magnesium hydroxide may be present in the glovebox. The filter could contain plutonium hydroxide precipitate, and multiple boats containing precipitate, including one on the hot plate, could be present. For analysis, the maximum amount of plutonium present in the glovebox was defined as the approximate quantity of plutonium in five batches, or 14 kilograms (30.8 pounds): 11.5 kilograms (25.3 pounds) in the form of hydroxide (on the filter, in the boats, and in miscellaneous sweepings from cleanup); and 2.5 kilograms (5.5 pounds) in the form of nitrate (aqueous feed). This represents an increase in the inventory of material at risk from the aforementioned 704 grams (1.5 pounds) considered in the PFP EIS (Section 5.2.1.2).

Estimated doses and health effects from current magnesium hydroxide precipitation accident scenarios are shown in Table 5. For the PFP Facility worker an increase in the inventory of material at risk results in a direct, linear increase in potential consequences.⁶ Thus, increasing the material at risk from 704 grams to 14 kilograms would increase the potential dose to the hypothetical maximally exposed PFP Facility worker from the aforementioned 0.072 person-rem to 1.4 person-rem (which equates to 0.0006 LCFs).

⁶ Appendix D (Section D.5.1) of the PFP EIS provides details on the methodology used to evaluate the health effects from an operational event during routine stabilization activities.

Table. 5. Estimated Doses and Health Effects from Current Mg(OH)₂ Precipitation Accident Scenarios*

	Doses (effective dose equivalent)			Latent Cancer Fatalities		
	Maximum Onsite Hanford Worker (rem)	Maximum. Site Boundary Individual (rem)	PFP Workers (person-rem)	Maximum Onsite Hanford Worker	Maximum Site Boundary Individual	PFP Workers
Glovebox fire	3.0×10^{-3}	1.0×10^{-3}	1.4	1.2×10^{-6}	5.0×10^{-7}	0.0006
Glovebox seismic event	1.5×10^{-1}	5.0×10^{-2}	1.4	6.0×10^{-5}	2.5×10^{-5}	0.0006

* Letter, dated June 28, 2000; R. D. Hanson to K.A. Klein, *Contract Number DE-AC06-96RL13200; Engineering Change Notice 658096, "Incorporation of the Magnesium Hydroxide Precipitation Process Addendum to the Plutonium Finishing Project Final Safety Analysis Report,"* and *Engineering Change Notice 659386, "Modification of WHC -SD-CP-OSR-010 Plutonium Finishing Plant Operational Safety Requirements Revision 0 -M to Support Plutonium Stabilization and Disposition Activities."*

Impacts to the onsite worker and offsite individual as a result of this postulated accident scenario also were evaluated. As a result of this postulated glovebox fire, approximately 5.7 grams (0.13 pound) of plutonium could be released into the facility. Quantities of smoke and soot generated by this glovebox fire would not be large enough to plug the ventilation system high-efficiency particulate air (HEPA) filters. Moisture generated by the fire would have no effect on the HEPA filters. Hot gases and smoke generated by the fire would be exhausted through the operational ventilation system HEPA filtration, resulting in approximately 0.003 grams (7×10^{-6} pounds) of respirable plutonium to be discharged from the 291-Z-1 stack. The onsite and offsite EDE doses resulting from this event are 0.003 rem and 0.001 rem, respectively.

- Glovebox Seismic Event

In the event of a postulated design basis earthquake (DBE), it was assumed physical forces cause the filter and boats on the glovebox floor to vibrate and shake, the boat on the heater to fall, and aqueous solutions in the precipitators (which fail) to spill. As with the aforementioned glovebox fire, for analysis the maximum amount of plutonium present in the glovebox was defined as the approximate quantity of plutonium in five batches, or 14 kilograms (30.8 pounds): 11.5 kilograms (25.3 pounds) in the form of hydroxide (on the filter, in the boats, and in miscellaneous sweepings from cleanup); and 2.5 kilograms (5.5 pounds) in the form of nitrate (aqueous feed). Thus, the same potential impacts to PFP Facility workers exist as with the glovebox fire.

As a result of this event, approximately 0.17 grams (0.004 pound, worst case) of plutonium is assumed to be released into the facility. Gravitational settling (16 percent) within the facility occurs, allowing 0.14 grams (0.003 pound) to escape unfiltered through the exhaust stack. The onsite and offsite EDE doses from the postulated glovebox seismic event are 0.15 rem and 0.05 rem, respectively.

As discussed in the aforementioned addendum to the PFP FSAR, the annual probability of accident scenarios involving either the glovebox fire or the DBE is given in the PFP FSAR as 1×10^{-4} . For the purposes of calculating a bounding level, the events in the scenarios were assumed to occur with a

conditional probability of one (1) given the occurrence of the event. The total onsite and offsite doses along with the Risk Acceptance Guidelines for a frequency of 1×10^{-4} were compared. All doses were within the Risk Acceptance Guidelines.

Further, as stated in the addendum, no effects on accidents currently analyzed in the FSAR are expected from operation of the magnesium hydroxide precipitation process, except for the seismic event. For the seismic event, magnesium hydroxide precipitation process operations will result in an addition to the total plant release when the existing exhaust systems continue to run but the HEPA filters fail, such that material is released unfiltered through the 291-Z-1 stack. No effects on abnormal operations currently analyzed in the FSAR are expected from operation of the magnesium hydroxide precipitation process.

CONCLUSION

The proposed action for stabilizing plutonium-bearing solutions at PFP via a magnesium hydroxide precipitation process is not changed substantially in matters relevant to environmental concerns from the stabilization process analyzed in the PFP EIS. There are no significant circumstances or new information relevant to environmental concerns associated with the proposal. Therefore, no supplemental EIS is necessary, and no additional NEPA review is required.

Issued at Richland, Washington, this 22nd day of September, 2000.



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APPENDIX A

Potential Environmental Impacts Comparison for Plutonium-Bearing Solutions: Magnesium Hydroxide Precipitation versus Ion-Exchange, Vertical Calcination, and Thermal Stabilization

Potential environmental impacts associated with magnesium hydroxide precipitation are similar to those anticipated for ion-exchange/vertical calcination/thermal stabilization (vertical calcination; the preferred alternative in the PFP EIS). For the purpose of this Appendix, the following is extracted from the PFP EIS (Chapter 5.0, Section 5.2, *ANTICIPATED IMPACTS OF THE ALTERNATIVE FOR PLUTONIUM-BEARING SOLUTIONS*):

Impacts from the alternative for plutonium-bearing solutions are evaluated in the following terms: anticipated health effects, physical environment; unavoidable adverse environmental impacts; and potential mitigation measures. For areas not identified, there would be no meaningful difference between the anticipated impacts associated with the preferred alternative and the anticipated impacts associated with alternatives discussed here.

Anticipated Health Effects (Table A.1)

- Under routine operations, minimal releases to the environment of radiological constituents are anticipated because of the extensive confinement barriers used at PFP. From a health effects standpoint, there would be no meaningful effect from this alternative on Hanford Site workers, the public, or the environment. However, health impacts to the PFP Facility workers are anticipated. The anticipated PFP Facility worker dose associated with the performance of this alternative is 85 person-rem. This dose results in a corresponding latent cancer fatality (LCF) of 0.03.
- To quantify the impacts from accidents associated with hydroxide precipitation, the fire/explosion accident is evaluated as bounding. The impacts from the muffle furnace accident described under the preferred alternative also would apply.
- Physical Environment (Table A.2)
- The hydroxide precipitation method would not have air emissions associated with the process, but the follow-up muffle furnace process would have projected emissions. The indicated particulate matter emissions for thermal stabilization would be made up of plutonium oxides that, for purposes of this portion of the EIS, were considered as a single emission contaminant, PM₁₀. From a standpoint of criteria pollutants from this alternative, the impact appears insignificant.
- Impacts to waste treatment, storage, and disposal capacity would be the same as those discussed for the preferred alternative.

Unavoidable Adverse Environmental Impacts

- Under routine operations, health impacts to PFP Facility workers would be anticipated. The total PFP Facility worker dose would be 85 person-rem with corresponding LCF of 0.03.
- Accident phenomena associated with the hydroxide precipitation followed by the thermal stabilization alternative could lead to unavoidable adverse environmental impacts. Because no accidents are anticipated, accidents are not expected to contribute to adverse environmental impacts. It is noted that the hazards and activities associated with the subject alternative generally do not possess sufficient energy to disperse radioactive and/or chemically hazardous materials in such a manner as to adversely affect Hanford Site workers, the public, or the environment. The dominant risk and safety concern associated with the subject alternative is for the PFP Facility workers.

Potential Mitigation Measures

- Potential mitigation measures have been discussed in the PFP EIS. To ensure that activities and consequences (e.g., radiological dose to PFP Facility workers) for normal/routine activities would remain within established requirements and protocol, and to ensure that the risk of accidents would be minimized, numerous measures would be taken in association with the hydroxide precipitation followed by thermal stabilization alternative. These measures include the use of engineered design features for gloveboxes consistent with standards and requirements for nuclear equipment. Examples of these programs are discussed elsewhere in the PFP EIS.

Table A.1. Radiation Exposures to Hanford Site Workers and the Public from Routine Operations*

Alternative	Doses (rem effective dose equivalent)			Latent Cancer Fatalities		
	Hanford Site worker population dose (5 workers) (person-rem)	Max. Site Boundary Individual (rem)	PFP Facility Worker (person-rem)	Hanford Site worker population dose (5 workers)	Max. Site Boundary Individual	PFP Facility Worker
Mg(OH) ₂ precipitation	2.0×10^{-4}	7.4×10^{-6}	8.5×10^1	7.9×10^{-8}	3.7×10^{-9}	3.4×10^{-2}
Vertical calcination	2.0×10^{-4}	7.4×10^{-6}	8.6×10^1	7.9×10^{-8}	3.7×10^{-9}	3.4×10^{-2}

*PFP EIS, Chapter 5 and Appendix D

Table A.2. Potential Environmental Impacts: Offgases and Effluents

COMPONENT	PFP EIS: Mg(OH) ₂ Precipitation ^a	PFP EIS: Vertical Calcination ^b
Air quality: Releases of PM ₁₀	1.4×10^{-8} grams/second (3.0×10^{-11} pounds/second)	Not Applicable
Air quality: Releases of Nitrogen Oxides	Not Applicable	9.8×10^{-3} grams/second (2.2×10^{-5} pounds/second)
Air quality: Releases of Plutonium Oxides	0.042 gram (9.3×10^{-5} pounds)	0.042 gram (9.3×10^{-5} pounds)
Filtrate – pH adjusted and liquid transferred to tank farms	~5,000 liters ((1,300 gallons)	~8,300 liters (2,200 gallons)
Filtrate – immobilized	~7.6 cubic meters (9.9 cubic yards) [40 208-liter (55-gallon) drums]	~12 cubic meters (16 cubic yards) [sixty-five 208-liter (55-gallon) drums]
Offgas condenser/caustic scrubber liquid waste stream – pH adjusted and liquid transferred to tank farms	Not applicable	32,000 liters (8,400 gallons) (could be routed for immobilization; no quantification provided)
Solid waste	Solid transuranic waste would be generated during glovebox operations. Design capacities of existing waste management facilities would not be exceeded.	Solid transuranic waste would be generated during glovebox operations. Design capacities of existing waste management facilities would not be exceeded. Additionally, 60 liters (16 gallons) of spent resin could be generated during ion exchange

^a Extracted from PFP EIS, Chapter 3.0, Section 3.3.1.1^b Extracted from PFP EIS, Chapter 3.0, Section 3.2.1.1

APPENDIX B

Potential Environmental Impacts from the Non-Thermal Treatment of Hanford Site Low-Level Mixed Waste

Extracted from DOE/EA-1189, *Non-Thermal Treatment of Hanford Site Low-Level Mixed Waste*

Potential environmental impacts associated with non-thermal treatment of Hanford Site low-level mixed waste were analyzed in DOE/EA-1189, *Non-Thermal Treatment of Hanford Site Low-Level Mixed Waste*. A maximum of 91,000 liters (24,000 gallons) of process filtrate from the magnesium hydroxide precipitation process would be generated which would require disposition. This represents less than 4 percent of the total Hanford waste volume in the scope of DOE/EA-1189.⁷ It is expected that the impacts of transport of process filtrate from PFP to the ATG Facility, treatment of the process filtrate at the ATG Facility, and return of the treated waste to the Hanford Site would be bounded by those impacts analyzed in DOE/EA-1189.

For the purpose of this Appendix, the following is extracted from the *Finding Of No Significant Impact*, DOE/EA-1189 (approved September 29, 1998):

“Radiation Impacts: No impacts from radiation are expected from normal safe operations. The radiological dose to workers from incident free transportation from the 200 West Area to ATG is calculated to be 0.025 person-rem/year, with an estimated 3 year cumulative radiological dose of 0.075 person-rem and a Latent Cancer Fatality (LCF) risk of 3.0×10^{-5} . The dose to the public from this transportation is calculated to be 0.029 person-rem, with 1.2×10^{-5} LCF. Transportation of the treated waste back to 200 West Area is calculated to result in 0.1 person-rem and 4.0×10^{-5} LCF to workers, with 0.039 person-rem and 1.6×10^{-5} to the general public. The three year cumulative radiological dose to the offsite population within 80 km (50 mi) of the ATG facility from normal operations is calculated to be 0.042 person-rem with 2.1×10^{-5} LCF. The collective dose to the work force from three years of operation would be 24 person-rem with an LCF risk of 0.0096.

Hazardous Material Impacts: Calculated health impacts from the hazardous constituents of the Hanford LLMW corresponded to excess cumulative cancer risks of less than 1.0×10^{-6} for both residential and workers scenarios. Therefore, the proposed action would be expected to result in no adverse health effects from routine air emissions.”

NOTE: Two calculations in the FONSI should be corrected. The dose to LCF conversion factor for the public is 5×10^{-4} . Thus, 0.029 person-rem equates to 1.4×10^{-5} LCF; and 0.039 person-rem equates to 2.0×10^{-5} LCF.

⁷ A total waste volume of 2,600 cubic meters (3,400 cubic yards) was evaluated in DOE/EA -1189. The composition of the aforementioned process filtrate waste stream from the magnesium hydroxide precipitation process is consistent with the physical and chemical characteristics of wastes analyzed in DOE/EA -1189. That is, contact-handled low-level mixed waste, which is made up of both low-level radioactive and hazardous constituents.

In addition, potential accident consequences during transportation were evaluated in DOE/EA-1189. The following synopsis is derived from Chapter 5.0, *Environmental Impacts of the Proposed Action*, of the aforementioned EA:

- Transportation, Radiological Risk

“The evaluation in Jacobs (1997) showed that the population health impacts from an accident while transporting low-level mixed waste would result in an annual health risk of $3.6\text{E-}04$ LCF. The analysis evaluated transportation accidents in heavily populated areas such as Vancouver, Washington; Spokane, Washington; and Seattle, Washington that would bound the consequences of an transportation accident that could potentially occur en route from the Hanford Site to the ATG Site. The evaluation in Jacobs (1997) was based on 475 trips per year, which would bound the probability of a transportation accident based on 16 trips per year, as evaluated in this EA.”

- Transportation, Chemical Risk

An accident would not result in any anticipated fatalities or the development of irreversible or serious health effects or the development of mild transient adverse effects.

- Transportation, Nonradiological/Nonchemical Transportation Impacts

During the 3 years of treatment, the number of injuries would be less than 1 (1.6×10^{-3}) and the number of fatalities would be less than 1 (5.5×10^{-5}).

APPENDIX C

Summary of Unreviewed Safety Question (USQ) Evaluation “Download Mg(OH)₂ Filtrate into 55 Gallon Drums” USQ Identification Number PFP-2000-31 Dated August 14, 2000

Description

The magnesium hydroxide precipitation process generates process filtrate, which could be routed to tank farms. Recent criticality, safety and operational issues with the 241-Z waste tanks has temporarily made 241-Z unavailable for receipt of the Mg(OH)₂ process filtrate. An alternate filtrate disposal plan was developed to load out filtrate from the process drain line into waste drums in the 234-5Z Building Tunnel #4. The filled low-level liquid waste drums could be transported to the Allied Technology Group (ATG) Mixed Waste Facility for non-thermal treatment of the waste. Treated waste would be returned to the Hanford Site for disposal.

Approximately fifty 208-liter (55-gallon) drums were considered in this evaluation. Secondary containment would be in an approved radiological containment tent or bag as required by radiological control and hazardous material management requirements. Filled drums would be sampled as necessary, and transferred from the tunnel to a loading dock. The drums would be shipped via truck overland to ATG for treatment.

Conclusion

The conclusion of the USQ evaluation is as follows: “The FSAR contains existing bounding abnormal event and accident analyses to adequately bound any abnormal event or accident that may involve the load out, collection, and shipment of low level liquid radioactive waste such as Mg(OH)₂ process filtrate.”